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# (54) Data communication network

(57) In a telecommunications network, charges generated in a domain of the network are determined by a call tariff dynamically determined by the domain and dependent upon the bandwidth reserved for or utilised by the call. Tariff data representing a change to the tariff is transmitted over the network before or during the call to the entity or entities liable to the domain for charges for the call. Customers for whom wide bandwidth is more important will be charged extra for it while those for whom bandwidth is less important can reduce their bandwidth requirements to avoid extra payment or to reduce their costs.

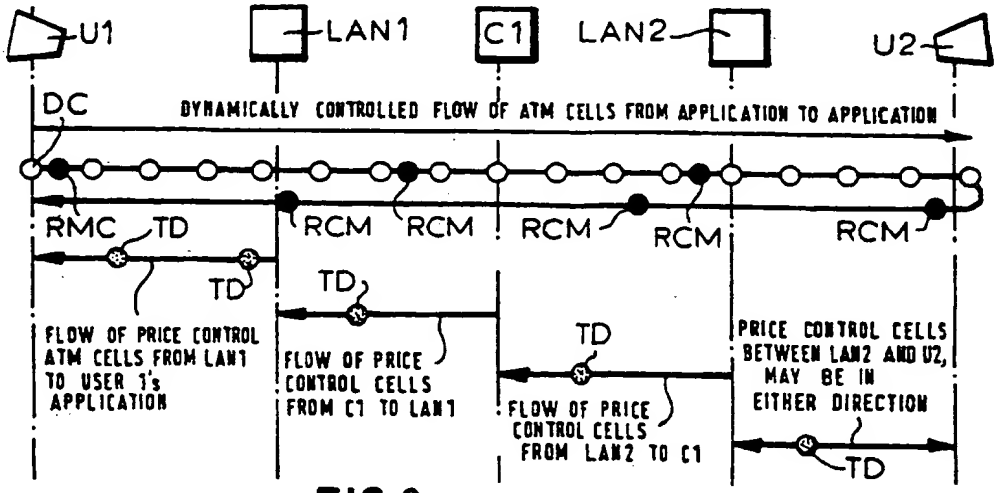


FIG.3

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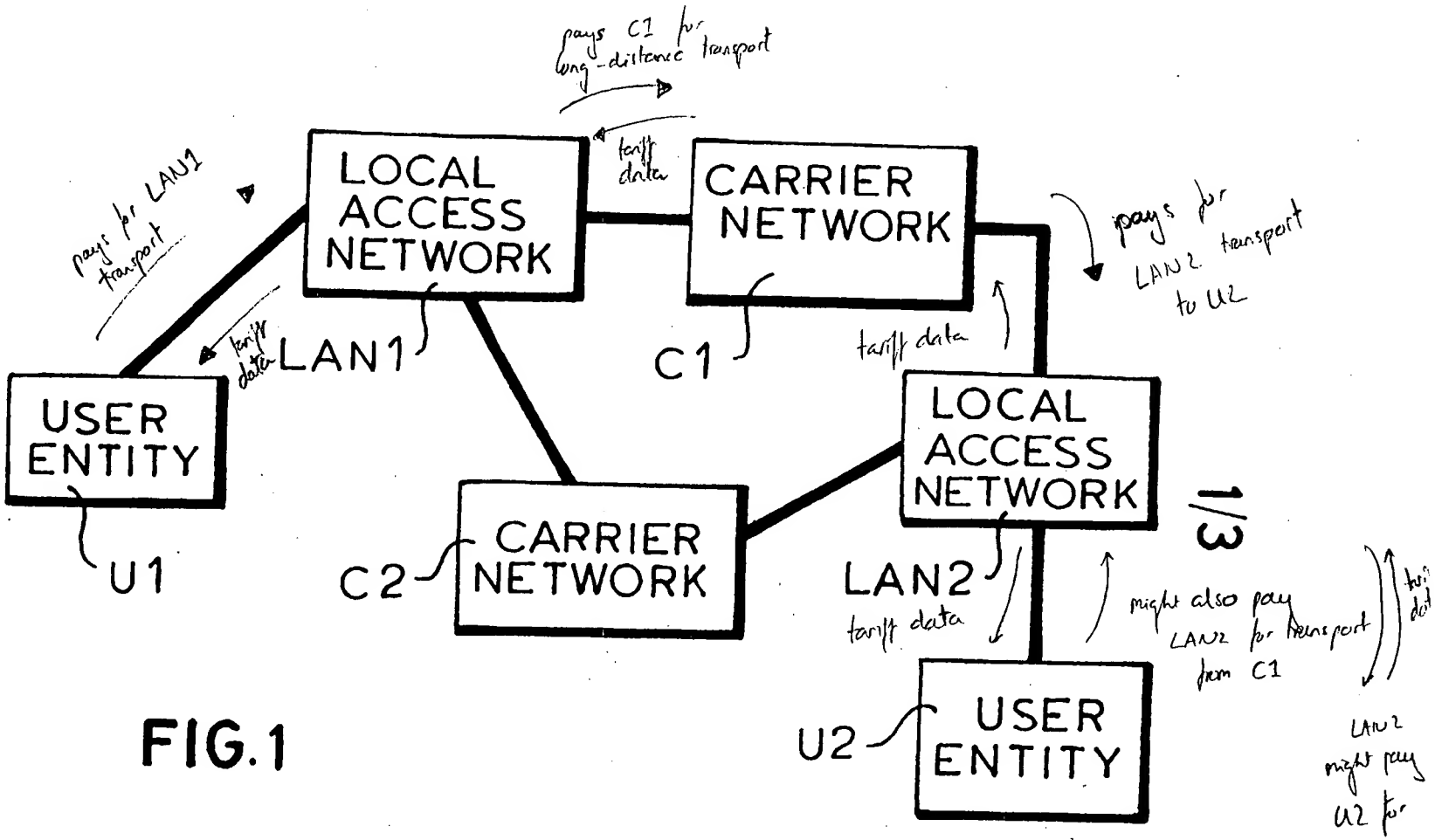


FIG.1

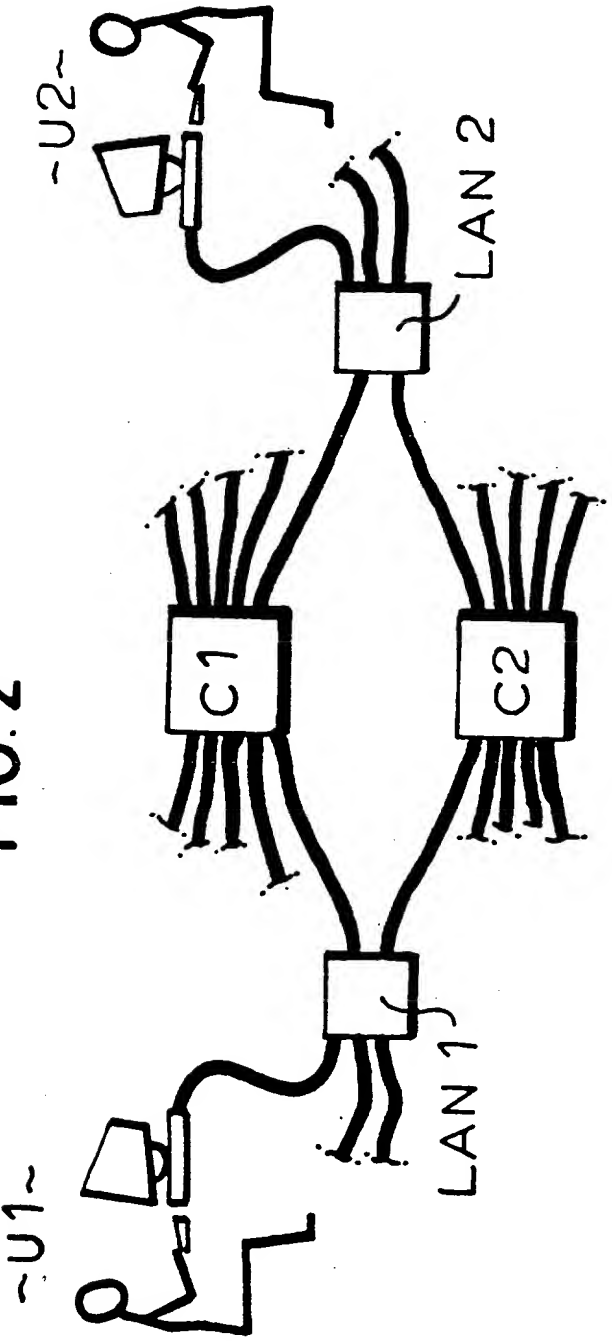


FIG. 2

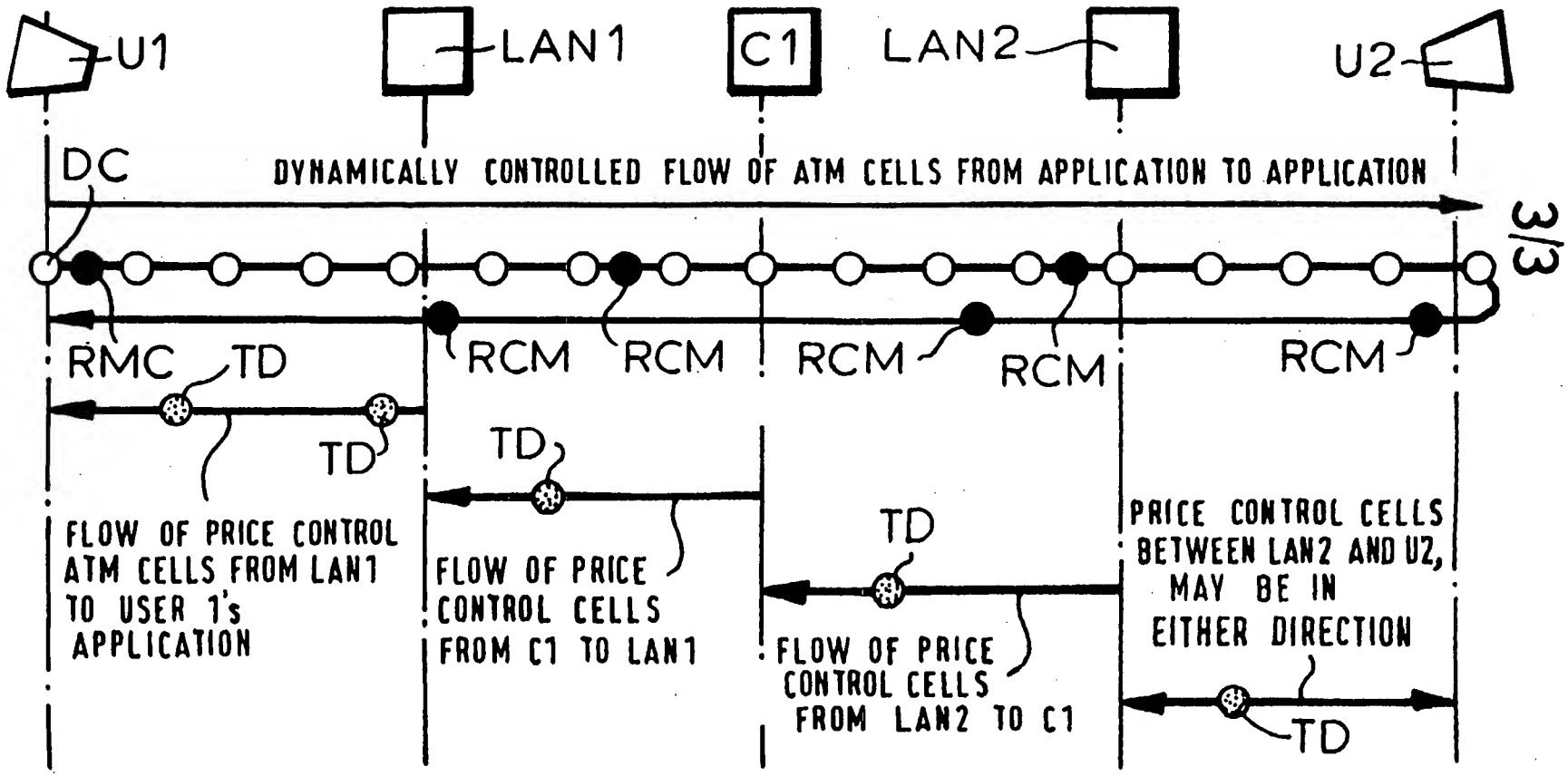


FIG.3

# Data Communication Network

This invention relates data communication networks.

The invention will be explained in relation to Asynchronous Transfer Mode (ATM) networks. It will be understood by the reader that the invention may be applied more broadly in networks providing a continuous flow of traffic of controllable bandwith. The invention may also be applied, for example, at the ATM SDH (Synchronous Digital Hierarchy) boundary.

Although it is conventional to design non-blocking networks for telephone traffic and for narrow band data communication networks, a non-blocking network for broad band data networks would not be easily affordable. Given that, from time to time, parts of a broad band network will become congested, a decision has to be made as to what to do on that occurrence. One option would be merely to refuse new calls. That used to be the practice in telephone networks. Another alternative, for which standards exist, is to control the bandwidth. Each sending application places resource management cells into the outgoing virtual circuit in addition to the conventional data cells. The resource management cells contain rate control information and are returned via a return virtual circuit to the sender. All of the network nodes monitor their utilisation and in the event of congestion or some other inability to deal with the rate demanded by the resource management cells process

the cells to indicate a lower rate. On receipt of the amended resource management cells, the sending application is contracted to reduce the rate to that specified in the amended cell.

In this system, all applications are treated equally. The invention is based on the recognition that equal treatment may not be fair in the sense that for some of the calls, bandwidth will be more important than for others.

Against this background, there is provided a network for carrying calls between entities, wherein domains of one or more network elements, which domains generate charges, determine the tariff for a call dynamically, dependent on the bandwidth reserved for and/or utilised by the call, and wherein tariff data representing at least a change or proposed change to the tariff is transmitted over the network before and/or during the call to the entity or entities liable to the domain for charges for the call.

The tariff may in some cases not result in the exchange of money or money's worth but could be used in, say a private network, for internal audit purposes.

A domain in the network is a group of one or more network elements which generate charges for their use. Thus a call transmitted through some of the network elements of a domain will attract charges. It is proposed that the customers for whom wide bandwidth is more important may be willing to pay extra for it, while those for whom wide

bandwidth is less important may prefer to reduce their bandwidth requirements so as to avoid extra payment or reduce their costs. The entity to which the tariff data is transmitted may be an end network element, if the domain is a local access network, or may be another domain. The tariff data may be altered at any time in response to commercial conditions and/or congestion in the domain, for example the price can be increased until congestion is controlled or merely to obtain the highest revenue for the domain.

Thus in a preferred embodiment, the tariff is dependent also on the current utilisation of network elements in the domain.

Whether a domain passes the received call charges on to its own customer may depend on a managerial business decision. In one form of the invention, the tariff depends selectively also on received tariff data.

In order for the ultimate customer to be able to make a decision, the or each network element liable for the call charges includes an arrangement for displaying the tariff indicated by, or the charge rate determined by, the tariff data.

The network element or elements liable for the call charges may include control means to reduce the transmission bandwidth of a call until the tariff indicated by the received tariff data is equal to or less than a value determined by a set of predetermined criteria. Preferably

the network element includes an arrangement for selecting different predetermined criteria. The network element also preferably includes means to override the control means selectively.

For each end network element there is preferably stored a class of service indicator, a local access network being arranged to determine the tariff dependent also on the class of service indicator. A user paying a low basic service fee (e.g. line rental) would be allocated a low class of service indicator and may have to pay premium charges for a broad band call, at a lower level of congestion than would a user paying a higher line rental and who would be allocated a higher class of service indicator. Alternatively or additionally, the user having the lower class of service indicator may have to pay a higher premium for a broad band call.

Thus the local access network may be arranged to calculate a utilisation indicator representing its own utilisation and the tariff determination may set the tariff to a value of zero when a combination of the value of the utilisation indicator and the value of the charge rate determined by the received tariff data is less than a level determined by the class of service indicator.

The invention extends to a method of operating a network to carry calls between entities, wherein domains of one or more network elements, which domains generate charges, determine the tariff for a call dynamically,

dependent on the bandwidth reserved for and/or utilised by the call, and wherein tariff data representing at least a change or proposed change to the tariff is transmitted over the network before and/or during the call to the entity or entities liable to the domain for charges for the call.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of a data communications network embodying the invention; and

Figure 2 is a schematic representation of a virtual circuit through the network of Figure 1; and

Figure 3 is a schematic representation of data flow in the virtual circuit of Figure 2.

Referring to Figure 1, the network comprises a number of entities. Users U1 and U2 are entities which may be connected to other entities by the network. Domains in the network are entities comprising a group of one or more network elements which generate charges for their use. Thus a call transmitted through some of the network elements of a domain will attract charges. A domain may include or consist of a service provider SP. Services may include, for example, a public bulletin board, one or more data bases, the provision of films, etc. A domain may include or consist of transmission elements, switching networks etc. being, for example, a local access network LAN1 or LAN2 or a long distance carrier network CN1 or CN2.

Figure 2 illustrates a call between user U1 and user U2.

Communications between users U1 and U2 and their respective local access network LAN1 or LAN2 is in multiples of 64 kbit/s synchronous channels. Narrow band communications, requiring one 64 kbit/s channel may provide, for example a telephone call. Broader band circuits containing a plurality of 64 kbit/s channels may be required for rapid data communication and, more especially, for video. Video may be wanted for transmission of film or television type material or for video conferencing. To transmit voice plus video of VCR quality requires a bandwidth of about 2 Mbit/s. Voice plus poor quality video may be provided in a bandwidth of 128 kbit/s (2 channels). Voice plus moderate quality video may be transmitted in a bandwidth of 768 kbit/s (6 channels).

The call may be carried between local access network LAN1 and local access network LAN2 by either carrier network CN1 or CN2.

Referring to Figure 3, data cells DC which carry the information user U1 wants to convey to user U2 are transported along a virtual circuit through the ATM network and arrive with their order preserved and with delays acceptable to voice and video communication. Interspersed between the data cells DC, resource management cells RCM are sent over the same route as the virtual circuit. The resource management cells contain rate control information.

Each element (Paul?) which provides the virtual circuit monitors its own utilisation. In the event that the element becomes unacceptably congested it processes the resource management cells to specify a lower rate. The resource management cells, having reached the application belonging to user U2, which may also process them to specify a lower rate, are returned on a return virtual circuit to the application belonging to user U1. The sending application belonging to user U1 is obliged to reduce the rate as specified.

This system of bandwidth control can remain in place in a network embodying the invention and would operate as an override in the event that large numbers of users decided they would pay the premium for broad band communication in the event of, for example, a major disaster.

In addition, or perhaps alternatively, the network is provided with means to communicate tariff data TD representing at least a change, or proposed change to the tariff, over the network before and/or during the call. The tariff data may be sent in the resource management cells RCM or may be sent separately. The tariff depends on the bandwidth reserved for or utilised by a call. Thus the resource management cells may be used to reserve bandwidth for a call and the tariff may be based on that reservation. Alternatively, or additionally, the tariff may reflect the actual bandwidth used by the call, and may thus reflect that the call is using less or more than the reserved bandwidth.

The tariff data is transmitted by each domain to the entity or entities liable for the charges for the service provided by that domain. The service would be transmission through the domain in the case, say, of local access networks LAN1 and LAN2, and carrier networks CN1 and CN2. The service would relate to time logged on a database, for example, in the case of service provider SP. In some cases, the tariff data will be transmitted towards the user originating the call. In other cases the tariff data will be transmitted towards a service provider, e.g. in the provision of services similar to the 0800 type telephone services.

The intention behind transmitting the information is to allow the domain manager to adjust the tariff in order to limit congestion of network elements in the domain. To this end, each user application is adapted to display the tariff information so that the user liable for the costs of the call can terminate the call if the tariff is judged too high, or can limit the bandwidth used in the call and modify the rate control information in the resource management cells RMC.

Thus in Figure 3, the entity comprising carrier network C1 is liable to the domain comprising local access network LAN2 for charges for the service by local access network LAN2 of transporting the data to user U2. Tariff data is therefore sent before establishment of the call from local access network LAN2 to carrier network C1. Local access network LAN2 may also charge for delivery to user U2,

in which case tariff data (which may be different) is transmitted also from local access network LAN2 to user U2. If user U2 is, say, a service provider, it may transmit tariff data to local access network LAN2. The tariff determined by the tariff data transmitted from local access network LAN2 to carrier network C1 may reflect the tariff determined by tariff data received by the local access network LAN2 from the user U2.

Similarly, the entity comprising local access network LA1 is liable to the domain comprising carrier network C1 for the charges for the carriage of the call through the carrier network. Tariff data is therefore sent before establishment of the call from carrier network C1 to local access network LA1. The tariff may reflect the tariff data received by the carrier network C1 from the local access network LA2.

The entity comprising user U1 is liable to the domain comprising local access network LAN1 for the charges for the carriage of the call through the local access network. Tariff data is therefore sent before establishment of the call from carrier network C1 to local access network LA1. The tariff may reflect the tariff data received by the local access network LAN1 from the carrier access network C1.

Tariff data may be transmitted from a domain to the entity which is liable to it during a call if the domain manager decides to vary the tariff. The tariff may be

increased, for example, in response to mounting congestion in the domain, and may be increased progressively until congestion is controlled to an acceptable level. The tariff may be determined merely to maximise revenue to the domain, so that the domain may operate with a degree of congestion which its users are prepared to pay for.

The tariff determined by a domain may directly reflect congestion in the domain. Thus the degree of utilisation of the network elements may be directly related to the price, the tariff depending directly on the bandwidth reserved for or utilised by a call and the current utilisation of the network.

In addition to the display of the tariff by the application belonging to the users U1 and U2, each application may include an arrangement for allocating a degree of priority to a call based on a set of criteria. Increasing charging rates defined by the received tariff data may be accepted, dependent on the criteria, or the bit rate may be reduced when the criteria are not met. The criteria may include a maximum charging rate, for example, or an average maximum charging rate. The criteria may be that a predetermined charging rate is exceeded for more than a set time. There may be a number of predetermined sets of criteria which may be selected according to user priority.

The application may allow the criteria to be changed or overridden during a call.

## CLAIMS

1. A network for carrying calls between entities, wherein domains of one or more network elements, which domains generate charges, determine the tariff for a call dynamically, dependent on the bandwidth reserved for and/or utilised by the call, and wherein tariff data representing at least a change or proposed change to the tariff is transmitted over the network before and/or during the call to the entity or entities liable to the domain for charges for the call.

2. A network as claimed in claim 1, wherein the tariff is dependent also on the current utilisation of network elements in the domain.

3. A network as claimed in claim 1 or claim 2, wherein the tariff depends selectively also on received tariff data.

4. A network as claimed in any preceding claim, wherein the network element liable for the call charges, includes an arrangement for displaying the tariff indicated by, or the charge rate determined by, the tariff data.

5. A network as claimed in any preceding claim, wherein the network element or elements liable for the call charges, includes control means to reduce the transmission bandwidth of a call until the tariff indicated by the received tariff data is equal to or less than a value determined by a set of predetermined criteria.

6. A network as claimed in claim 5, including

an arrangement for selecting different predetermined criteria.

7. A network as claimed in claim 5 or claim 6, including means to override the control means selectively.

8. A network as claimed in any preceding claim, wherein for each end network element there is stored a class of service indicator, a local access network being arranged to determine the tariff dependent also on the class of service indicator.

9. A network as claimed in claim 8, wherein the local access network is arranged to calculate a utilisation indicator representing its own utilisation and wherein the tariff determination sets the tariff to a value of zero when a combination of the value of the utilisation indicator and the value of the charge rate determined by the received tariff data is less than a level determined by the class of service indicator.

10. A method of operating a network to carry calls between entities, wherein domains of one or more network elements, which domains generate charges, determine the tariff for a call dynamically, dependent on the bandwidth reserved for and/or utilised by the call, and wherein tariff data representing at least a change or proposed change to the tariff is transmitted over the network before and/or during the call to the entity or entities liable to the domain for charges for the call.

11. A method as claimed in claim 10, wherein the

tariff is dependent also on the current utilisation of network elements in the domain.

12. A method as claimed in claim 10 or claim 11, wherein the tariff depends selectively also on received tariff data.

13. A method as claimed in any of claims 10 to 12, including displaying at the network element liable for the call charges, the charge rate determined, by the tariff data.

14. A method as claimed in any of claims 10 to 13, including the step, at the network element or elements liable for the call charges, of reducing the transmission bandwidth of a call until the tariff indicated by the received tariff data is equal to or less than a value determined by a set of predetermined criteria.

15. A method as claimed in claim 14, including the step of selecting different predetermined criteria.

16. A method as claimed in claim 14 or claim 15, including the step of overriding the control means selectively.

17. A method as claimed in any of claims 10 to 16, wherein for each end network element there is stored a class of service indicator, a local access network acting to determine the tariff dependent also on the class of service indicator.

18. A method as claimed in claim 17, wherein the local access network calculates a utilisation indicator

representing its own utilisation and wherein the tariff determination sets the tariff to a value of zero when a combination of the value of the utilisation indicator and the value of the charge rate determined by the received tariff data is less than a level determined by the class of service indicator.